$$\log \Gamma(x+1) = .6162372 + (x+\tfrac{1}{2})(\log x - \log e) + .080929 \sin \frac{25°.623}{x},$$

using seven-place logarithms except for the second or product term where ten-place logarithms were used to avoid introducing inaccuracies when x is large. This formula is also given in the introduction to "Tables for Statisticians and Biometricians" (Chicago University Press), on page lv, where unfortunately by a printer's error the value 0.3990899 is wrongly given as .03990899.

The various series of values are summarized in the following table.

VALUES OF LOG $\Gamma(n)$ BY DIFFERENT METHODS

n	Pearl's "Exact" Value	Pearl Forsyth	Pearl Using Δ^2	Pearl Using Δ^3	Pearson	"More Exact" Value
5.123	1.4613860	1.4613679	1.4619138	1.4615009	1.4613859	1.4613860
15.123	11.0834931	11.0834916	11.0835559	11.0834985	11.0834931	11.0834930
25.123	23.9637108	23.9637096	23.9637336	23.9637119	23.9637107	23.9637107
35.123	38.6594135	38.6594126	38.6594251	38.6594138	38.6594133	38.6594133
75.123	107.7498704	107.7498692	107.7498727	107.7498702[2]	107.7498702	107.7498702

The table shows that Dr. Pearl's "exact" value differs from the "more exact" value by two units in the seventh place for the larger values of n and in the case of $n = 75.123$ is inferior to the value found from interpolation when third differences are used.

A comparison of the values in the table leads to the following conclusions.

(i) For small values of n, up to about 5, it is preferable to use the exact method if Legendre's tables are available; in the absence of Legendre's tables the Pearson approximation formula should be used.

(ii) For larger values of n, as shown by the middle portion of the table, Pearson's formula is superior to the interpolation method and gives results which coincide with those found by the

(iii) For still larger values of n, 75 and upwards, the Pearson approximation formula and the interpolation method using third differences both give the true value to the seventh decimal place, but while the usefulness of the interpolation method is limited by the range of the existing tables of log-factorial n, that of the approximation method is not affected, provided a sufficient number of places be used in the logarithms of x and e when computing the second or product term.

P. F. Everitt

[2] Given as 107.7492870 in Dr. Pearl's article, being a misprint for the value given above, which I verified by recalculation.

THE POSITION OF REFERENCES IN JOURNAL ARTICLES

From one half to one per cent. of the space in the majority of scientific journals giving many references is wasted by the faulty position and arrangement of the references.

The amount of time wasted by the reader will depend on whether he is obliged to look up the references, or simply glances at them occasionally to see a date, or the name of an *author or journal.*

The word reference is defined here to mean the author's name, journal title (usually abbreviated), with the numbers for series, volume, pages and date. If any information from the original is also given, and printed at the bottom of a page outside the text, the whole is regarded as a foot-note, and is not considered here. "*Loc. cit.*," is regarded as a reference.

Most journals are printed with a solid page, at the foot of which are the references for that page, with the reference numbers indicated in the text, a separate line being given to each reference, except where extra space is required either because of grouping several references under one number, or because of unusual length of names.

Nearly one per cent. of the space used in printing articles and references in this way can be saved by giving each reference a number (the numbers to run consecutively), then printing all the references at the end of the article, leaving an extra-wide spacing between the period at the end of one reference and the next number, in order to catch the eye. There

is nothing new in this method, for it has been used at rare intervals for a number of years.

The following illustrations taken at random from a number of measurements, show the state of the case as regards chemical journals, but the proposition is equally true for the journals of other sciences. The measurements have been made on the supposition that the same sized type will be used in both ways of printing the references. A space of five millimeters is allowed between the period at the end of one reference and the beginning of the number of the next, and extra space is allowed for in the case of articles containing over ten references, for these will require the use of numbers with two figures. Thus, an article with sixty separate references printed in the customary way will have, as a rule, from two to eight references on the page, and rarely require the use of reference numbers with two figures, while the shorter way requires the use of numbers up to sixty both in the text and at the end of the article.

A consideration of those illustrations in which the number of pages with no references is given, will make two facts obvious; that the estimate of the amount of space saved is only a rough approximation; and that it might easily be possible by deliberate selection of one hundred pages to get results widely different from those given here.

In the leading English journal, the *Journal of the Chemical Society,* all the references are printed in the text, so that there is no saving of space. In the *Journal of the Society of Chemical Industry,* Volume 32, 457–995 (1913), containing 100 pages of text of articles, about one eighth of a page could be saved. This journal has two columns to the page. Several of the articles have all the references at the end of the article.

In the *Bulletin de la société chimique de France,* Volume 13, 320–457 (1913), containing 100 pages of text of articles, over one half a page could be saved. There are 62 pages with no references. Some of the articles have the references printed two to the line, with extra space between the two.

In the *Berichte der deutschen chemischen Gesellschaft,* Volume 45, 403–503 (1912), about one half a page could be saved. The references in this journal at present are greatly abbreviated, thus, B. stands for the title of *Berichte,* etc. If space allows, instead of printing the references one to a line, they are always printed two to a line, with a space of 5 to 15 millimeters between the two. This method (a step in the right direction) naturally limits the saving possible. There are 61 pages with no references.

In the *Gazzetta chimica italiana,* Volume 42, I., 316–416 (1912), nearly three quarters of a page could be saved. There are 61 pages with no references.

In the *Journal of the American Chemical Society,* Volume 34, 1631–1731 (1912), one page can be saved. There are 54 pages with no references. In the *Physical Review* an article always begins at the top of a page. The effect of this is that there is sufficient space at the end of most articles to print all the references, often on the basis of a line for each reference.

In the case of journals printed with two columns to a page, there is an incredible numbers of variations in the way in which numbers indicating references are used, as, for instance, giving numbers consecutively for the references in one article regardless of the number of columns used for the articles, or using numbers consecutively for one column regardless of the number of articles in that column, etc. These variations doubtless relieve the monotony of the work of editors, printers and proof-readers.

There is one great advantage in the method recommended here. It does away with "*loc. cit.,*" the abbreviation so easy to write, so saving of time and space in printing, so wasteful of time to one who has to go back an indefinite number of pages and read an indefinite number of references, in order to find where the authority for a given statement may be found. When many articles by one author, or many patents by one man are given, this "*loc. cit.*" may be so indefinite that it will be necessary to look through a number of the originals in order to get at the one desired. In a series of

articles, "*loc. cit.*" may refer to a reference published in a preceding article, sometimes to one in a preceding volume. In one case approaching the limit of misuse, the statement in the text reads, "Harvard[2] and Princeton[3] laboratories." The reference number 2 is to "*loc. cit.*" On looking at reference number 1 it is found that the word "Harvard" is not mentioned at all. In order to make sure that this "*loc. cit.*" did not refer to a reference in some preceding article, both the publications under number 1 would have to be noted and examined by any one unfamiliar with the fact that a man with a certain name, interested in a certain subject, was writing articles coming from Harvard in a particular year. This contingency will arise in some future time.

There are two classes of readers interested in the position of references. The reader who wishes only to see the date of a statement referred to in the text, or the name of the journal in which the statement was published, naturally finds it easier to look down at the foot of the page, instead of turning to the end. But the reader who wishes to look up an original article is willing to take this small trouble of turning to the end, especially when it saves time in the long run. Having had to read through articles, and look over references which ran in number into the hundreds of thousands, then look up thousands of the original articles from these references, I can speak from adequate experience of the positive value of the method recommended here, for it was always a pleasure and relief to come across the few articles using it.

Since there is a constant plea for saving of space in articles presented to scientific journals, a method of economy which will save from one half to one per cent. of the space now used, and at the same time increase the ease of looking up references and authorities, seems worthy of consideration.

Heyward Scudder

SCIENTIFIC BOOKS

Essays and Addresses. By the late James Campbell Brown, D.Sc. (Lond.), LL.D. (Abdn.), Professor of Chemistry in the University of Liverpool. With a Portrait and Twenty-two Illustrations. London, J. & A. Churchill. 1914. Pp. x + 208. Price $2.00 net.

A memorial volume is always of interest to the former students of a loved professor and to such this collection of essays and addresses by the late Dr. Campbell Brown will chiefly appeal; but from another standpoint this book is of interest not merely to chemists, but to all who come into touch with chemical industry, in that it presents the opinions of a discerning critic, expressed from time to time in a more or less popular way to audiences interested in the development and utilization of chemistry. This is particularly true at the present time when so many are turning their attention to the applications of chemistry to conditions of war.

Of the twelve addresses, three were delivered as chairman of the Liverpool Section of the Society of Chemical Industry, five before the Students' Chemical Society of University College, Liverpool, and two before joint meetings of the societies of the same college. The period covered in these addresses is 1886 to 1908, and many of the thoughts are equally applicable to the present time, especially those dealing with education.

It is interesting to read in the address on Technical Education delivered in 1886, Dr. Brown's strong plea for linking a sound early mental training with education of the hands, an idea which has been developed in this country along the line of the manual-training schools. Dr. Brown would, however, solve the problem along somewhat different lines. He would have workshops for different kinds of trades erected in a few well-chosen districts of a town, and require each scholar to spend a sixth day of every week in one or other of these shops, such day being counted as a part of regular school attendance. A single workshop would thus serve for a considerable number of graded schools, and the workshop day would be looked forward to as almost a holiday. He says: "By this system I do not think that the amount of ordinary school work would be lessened; but if it were, the decrease would